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CLASSIFICATION

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CANADIAN PATENT

LINER EXPANDER

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PRIORITY DATE

No. OF CLAIMS

LINER EXPANDER

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This invention relates to a constant force spring device, and more particularly, to a device for expanding a metallic liner wherein an expanding die is urged against the liner by a constant force spring device.

Heretofore, a method and apparatus have been developed for installing an expanded metallic liner in an oil well or other conduit. Typically, a corrugated steel liner is inserted in a conduit which is to be lined, the greatest peripheral dimension of the liner being slightly less than the inside diameter of the conduit. An expanding tool is passed through the liner placed in the conduit, and a first-stage expanding die causes a gross plastic deformation of the liner, which is expanded outwardly against the inside of the conduit. A second-stage die on the tool then provides an additional finer deformation of the liner to provide a smoother, more finished surface on the inside of the liner and to assure more complete contact between the conduit and the liner. In a typical design of this type expanding tool, the frictional drag of the first-stage die supplies the expanding force for the second-stage die, which expanding force is a direct function of the strength, or wall thickness, of the conduit in which the liner is being installed. For example, in lining oil well casing, heavy wall casing may cause a very high frictional force which results in excessive pressure being required to push the expander through the liner. The application of the great forces required may result in rupture of the casing or in breaking the installing tool. In instances where the internal diameter of the conduit is somewhat less than that anticipated, the resulting forces can cause the tool to become stuck in the casing, or otherwise cause damage to the casing and the tool. In other designs, such as where a cantilever spring arrangement is employed in connection with the secondstage die, various difficulties are encountered in obtaining a spring mechanism having the desired strength in combination with the other spring characteristics, and with the tool dragging against the inside wall of the conduit after being passed through the liner.

Since tools of the type mentioned above often are employed in wells deep in the ground, it is highly preferable that a tool be used which under no circumstances will become stuck in the well or cause damage to the well. Any such trouble occurring in a well can result in considerable loss in time and great expense in making repairs.

An object of the present invention is a device for applying a constant force to an expanding die or other similar apparatus so that a preselected maximum force is exerted against a work piece. Another object is an improved expanding tool for installing metallic liners in a conduit, which expanding tool can apply no greater than a predetermined force to the liner being installed in the conduit. Still another object of the invention is an economical and easily fabricated constant force spring device. A further object is a rugged, easy-to-operate expanding tool employing such a spring device. These and other objects of the invention will become apparent by reference to the following description of the invention.

In accordance with the present invention there is provided a constant force spring device which comprises a body member, an elongated column element adjacent said body member, bearing plate members contacting the two ends of said column at least one of said bearing plate members being longitudinally movable in respect of the other and stop means on said body member to limit the deflection of said column element to prevent permanent deformation of said column element upon the application of a compressive load thereto. In one embodiment of the invention, the foregoing constant force spring device is employed in a tool for expanding a metallic liner inside a conduit, said constant force spring device being positioned on said tool to urge an expanding die member against the liner being installed in the conduit by a substantially constant force.

My invention will be better understood by reference to the following description and the accompanying drawings wherein:

Figures 1A, 1B and 1C, taken together, constitute a partial sectional view of a preferred embodiment of a liner expanding tool according to the present invention; and

Figure 2 is a sectional view of the apparatus of Figure 1A taken at line 2-2; and

Figure 3 is a typical plot of applied Load versus Deflection for the constant force spring device of the invention.

Referring to the drawings, Figure 1A is the bottom portion of a liner expanding tool for use in installing a metallic liner in a well, while Figure 1B illustrates the middle section of such a tool and Figure 1C represents the upper section of the tool. The expanding tool 11 is attached to standard well tubing 12 by coupling 13 and, typically, may be lowered from the surface through a well casing (not shown) to a point in the casing at which it is desired to install a metallic liner. Before inserting the tool into the well, an elongated vertically corrugated liner 14 fabricated from mild steel. or other suitable malleable material, is placed on the tool. The corrugated liner is secured in position by contact at its upper end with a cylindrical shoulder member 16 and, at its lower end by contact with a first-stage expanding die 17 in the form of a truncated circular cone which serves as a firststage expanding die in the manner hereinafter described. The expanding die is fixedly attached to a centrally located, elongated cylindrical hollow shaft 18 which forms a portion of the body of the tool. As shown, the expanding die 17 is held in place between a lower shoulder 19 and collar 21 threaded onto the shaft. A plurality of movable arms 22, preferably provided with outwardly enlarged portions 23 near the top, are disposed in the form of a cylinder around shaft 18. The enlarged portions of the arms 25 upon being moved outwardly contact the liner to perform the final step of expanding the corrugated liner into a substantially cylindrical shape. The arm members 22 are pivotally attached to the chaft so as to be movable outwardly from the shaft by a tapered expanding member 24 slidably positioned on the shaft to serve as a second-stage expander. The surface of the member 24, as shown, moves upwardly along the shaft to engage with the arms and move them outwardly. Advantageously, the inside surfaces of the arms 22 and the outside surface of expanding member 24 form mating sections, typically octagonal in shape. The expansion of the arm members is controlled by the position of the member 24 which moves upwardly

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until it contacts shoulder 26 provided on the shaft. As member 24 moves in a downwardly direction arms 22 fold inwardly toward the shaft. The expanding arms 22 are held in place on the shaft by collar 27 and circular groove 28 provided on the shaft.

The expanding tool, comprising the first-stage die and the secondstage die is drawn through the liner to expand it in place in the casing. The
first-stage die provides a gross deformation of the liner so that it is
expanded outwardly against the wall of the casing. The second-stage die then
passes through the liner and performs the final expansion to smooth the inner
surface of the liner and to provide more even contact between the liner and
the wall of the casing and effect a fluid-tight seal.

In operation, the liner setting tool is assembled at the surface, as described above, and a glass cloth saturated with a resinous material may be wrapped around the corrugated tube to form the liner. The assembly is lowered into the well at the location at which the liner is to be set. A liquid, such as oil, is then pumped under pressure down the well tubing and flows through the passageway 29 provided in polished rod 31, through ports 32 and into cylinder 33 connected to the upper end of the shoulder 16. Upon the application of fluid pressure to the cylinder, the piston 34 secured to polished rod 31 moves upwardly in cylinder 33. As shown, rod 36 connects polished rod 31 and shaft 18 upon which is mounted the first-stage expanding die 17. When the piston 34 moves upwardly through the cylinder 33 the expanding die 17 and the secondstage die 22 are drawn upwardly into the corrugated liner 14 and "iron out" the corrugations in the liner, so that the expanded liner may contact the inside wall of the casing in which it is being installed. Positioned on the shaft below the expanding member 24 is a constant force spring member 37 which is employed to urge the expanding member against the expanding arms 22 with a substantially constant force. The force exerted against the arm members being substantially constant, the force transmitted through the arm members to the liner and to the coming will be substantially constant so that either sticking of the tool in the casing or rupture of the casing is procluded. Of course, the force provided by the opring member is procedected so that the frictional

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forces between the tool and the liner and the pressure exerted against the casing are maintained at predetermined safe levels. The constant force spring member assures that the contact pressure between the liner forming portion 25 of the arms 22 is great enough to provide the desired deformation of the casing, while preventing damage to the casing or to the tool.

The constant force spring member 37 is slidably mounted on the shaft 18 and held between the expanding element 24 and a cylindrical lower shoulder member 38 forming a portion of a differential screw element 39 which transmits the losding on spring member 37 to shaft member 18. The differential screw element comprises shaft member 18 on the outside of which are cut male threads 18s, the lower shoulder member 38 provided with female threads 38s and thimble member 41 provided with threads 41a and 41b on the outside and the inside, respectively, to engage with threads on the shaft and the shoulder. The two sets of threads are coarse, such as square, modified square, or Acme threads, to withstand very high loads and differ in pitch so that shoulder 38 is moved upwardly on the shaft 18 when the shaft is revolved relative to thimble 41. The shoulder 38 is secured to the shaft 18 by splines 45 so that it can slide longitudinally, but it is not free to rotate on the shaft. Fixedly attached to the lower end of the thimble is a friction member, such as bow springs 42, a hydraulically actuated friction pad, or other such device for frictionally engaging with the inside wall of the conduit to secure the thimble against rotation with respect to the shaft. Preferably, the direction of the shoulder member threads 38m is the same as that of the shaft threads 18m, e.g. righthand threads, and the pitch, or lead, of threads 18a is slightly greater than that of threads 36s, with the pitch ratio being close to unity. In this manner, clock-wise revolution of the shaft relative to the thimble causes shoulder member 38 to advance upward slightly and a compression load is exerted upwardly on spring element 37 to cause buckling. For example, one satisfactory differential screw was made up using five and one-half threads/inch square threads on a shaft approximately 1.7-inch outside diameter and five and threequarters threads/inch square threads on a shoulder approximately 2.5-inches inside diameter.

Constant force spring element 37 comprises column element 43, advantageously consisting of a plurality of elongated columns disposed around shaft 18. Upper bearing plate member 44 is in contact with the upper ends of the columns and is slidably positioned on shaft 18 to transmit the force of the spring longitudinally against the bottom end of expander member 24. Lower bearing plate member 46 contacts the lower ends of the columns and is moved upwardly along the shaft by longitudinal movement of lower shoulder 38 as a result of revolving differential screw element 39. Grooves 47 are provided in each of the bearing plates, to form an upper race and a lower race, into which the ends of the columns are inserted. These grooves may be shaped to conform with the shape of the column ends if desired. A cover 48 may be employed to exclude foreign matter from the spring mechanism and to protect the spring.

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A means for limiting the deflection of the columns is required. Although the column element functions in a buckled condition, application of excessive compressive load thereto would cause total failure or rupture of the columns. Therefore, a pair of stops 49 and 49a are provided for this purpose. As shown, the stops are rigidly connected to the bearing plates, and, in effect comprise upper and lower limiting sleeves positioned on the shaft to slide longitudinally thereon. The ends of the stops may move toward, or away from, each other as the load on the spring member varies. Lower sleeve 49a is prevented from moving down by lower shoulder 38 connected to the shaft 18. However, the spacing between the ends is such as to limit the longitudinal travel of the bearing plate members as they move together to prevent permanent deformation of the column element 43. Various alternative means for preventing damage to the column element may also be employed. For example, pine or rings mounted on the shaft may serve as stops, or the cover 48 provided with suitable connections may be employed for this purpose to limit longitudinal and/or lateral deflection of columns.

The columns of the column element 43 may be arranged around the shaft 18, which as shown here forms a portion of the body of the spring device, with ends of the columns fitted in the races 47. The columns may be

fitted closely together as shown, or may be spaced around the race, with separators used between them to maintain the desired spacing. The number of columns employed will depend upon column characteristics and the materials of construction. For example, the slenderness ratio of the column may be varied widely, and the column ends may be round, flat, fixed or hinged. The preferred construction is a thin, slender column with rounded ends, free to move within the races shaped to the curvature of the column ends. Materials which may be satisfactorily employed for the columns are carbon and low alloy steels, chromium and nickel-chromium stainless steels, various copper base alloys, such as phosphor bronze, beryllium copper, the high nickel alloys and other similar materials providing satisfactory mechanical properties. Typically, the individual columns are of long rectangular cross-section, with the width being greater than the thickness, and arranged so that the wider face of the columns is normal to the diameter of the shaft. Thus, with sufficient compression loading, the columns buckle, and bend about the axis having the least moment of inertia, e.g., outwardly away from the shaft 13.

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For example, a group of columns 0.167-inch thick by 0.438-inch wide by 10.626-inches long, with the ends rounded, were fabricated from A.I.S.I 4340 steel, quenched and drawn at 575°F. Each column was found to require a 20 critical compression loading of 450 pounds in order to buckle the column. After buckling, the columns were found to have a very flat spring characteristic, as shown in Figure 3, wherein Pc is the critical buckling load and point C represents the load and deflection at which the stress in the extreme fibers of the column exceed the yield point of the material. Theoretically, the shape of this spring characteristic curve is described by curve OA'ABC. Actually, this curve is described by OABC due to friction in the system. Points A and B represent typical working limits, which, of course, may be varied according to the application for which the spring is designed. For example, where a large number of flexing cycles are not anticipated, a working stress just below the 30 yield point may be used, while with a great number of flexures, the working stress may be held to less than the endurance limit of the material of construction. In the above-mentioned tests, the lateral deflection was limited to

spproximately one inch, at which the longitudinal deflection was approximately: 0.225 inches. From zero deflection to the maximum deflection, the 450-pound loading was found to be substantially constant.

In another test a spring device was built, as shown, employing 20 columns, each having a critical buckling load of 1250 pounds. The lateral deflection was limited between 0 and about 1.00 inches by appropriately positioning the stops. Upon compressional loading, the spring element buckled at substantially 25,000 pounds and from a longitudinal deflection of 0.04 inches (buckling) to about 0.15 inches the load remained substantially at 25,000 pounds.

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Of course, in designing a spring element as above it is advantageous to obtain the greatest possible value of longitudinal deflection for specified values of lateral deflection and critical buckling load, while maintaining the stress level in the columns at a safe level. The preferred columns, therefore, are laminated, as shown in Figures 1B and 2, with multiple flat members making up each column.

In the operation of the above expanding tool for setting a liner in vell casing, the made-up tool is lowered into the well as montioned above, with the arms 22 in the retracted position. When the tool is at the desired level, the well tubing is revolved. The friction member \$2\$ engages with the wall of the casing and prevents thimble \$1\$ from revolving. With several revolutions of the tubing, lower shoulder 38 is moved upwardly by differential screw 39 to bucklo spring element 37 which has a predetermined critical buckling load. This load is transmitted upwardly against the lower end of expander 24, and its topored surface is engaged with the tapered surface on the inside of the arms 22 to urge the arms outwardly with a substantially constant force proportional to the critical buckling load of the spring element. Subsequently, the expanding tool is passed through the liner to expand it in the casing in the manner described hereinbefore.

The foregoing description of a preferred embodiment of my invention has been given for the purpose of exemplification. It will be understood that various modifications in the details of construction will become apparent to

the artisan from the description, and, as such, these fall within the spirit and scope of my invention.

I CLAIM:

- 1. A device for expanding a metallic liner inside a conduit which device comprises a shaft element, an expanding die member attached to said shaft element, said die member comprising a movable liner-forming member positioned on said shaft and being radially movable in respect thereof to contact said liner, an expander member slidably positioned on said shaft between said shaft and said die member to move said liner-forming member from said shaft, and a constant force spring member positioned on said shaft to contact said expander member and to maintain said expander member against said liner-forming member, whereby said liner-forming member is urged against said liner by a substantially constant force.
 - 2. In a device for installing an expanded metallic liner in a conduit wherein an expanding die is moved through a liner positioned in said conduit to expand said liner: a cylindrical shaft element, an expanding die member attached to said shaft, said die member comprising a plurality of arm members disposed around said shaft and being pivotable outwardly therefrom to contact said liner, a cone member slidably positioned on said shaft between said shaft and said arm members to urge said arm members outwardly from said shaft, and a constant force spring member positioned on said shaft to contact said cone member and to maintain said cone member in contact with said arm members, whereby said arm members are urged outwardly by a substantially constant force.
 - 3. The device of Claim 2 wherein said constant force spring member comprises a plurality of columns disposed around said shaft, a first bearing plate member and a second bearing plate member, each of said bearing plate members contacting opposite ends of said columns, at least one of said bearing plate members being movebly positioned on said shaft and being in contact with said come member, stop means connected to said shaft to limit the axial travel of said moveble bearing plate member along said shaft, and compression means for maintaining a lateral deflection in said columns.

- 1 4. The device of Claim 3 wherein said compression means comprises
 2 a differential screw connecting said spring member and said shaft.
 - 5. The device of Claim 3 wherein said stop means comprises a sleeve-like element connected to said movable bearing plate member and slidably positioned on said shaft and a member connected to said shaft to limit the travel of said sleeve-like element.
 - 6. The device of Claim 3 wherein said columns have a rectangular cross-section, the width being greater than the thickness, and having the wider face normal to the diameter of said shaft.
 - 7. A device for installing an expanded metallic liner in a conduit which comprises a cylindrical shaft element; an expanding die member mounted on said shaft, said die member comprising a plurality of arm members disposed circumferentially around the outside of said shaft and being pivotable outwardly therefrom to contact the liner; a conical expanding member slidably positioned on said shaft between said shaft and said arm members to urge said arm members outwardly from said shaft; a plurality of slender columns, each having a long rectangular cross-section and disposed circumferentially about said shaft; an upper bearing plate member and a lower bearing plate member, each slidably positioned on said shaft and contacting opposite ends of said columns; limiting sleeves attached to each of said bearing plate members and slidably positioned on said shaft; a shoulder momber on said shaft; a differential screw element connecting said shoulder and said shaft to apply a buckling load to said columns; said shoulder being engageable with the limiting sleeve connected to said lower bearing plate member, whereby the exial traval of said bearing plato mombers is limited; said column members transmitting their buckling load to said arm mambers to urge said arm mambers outwardly with a substantially constant force.

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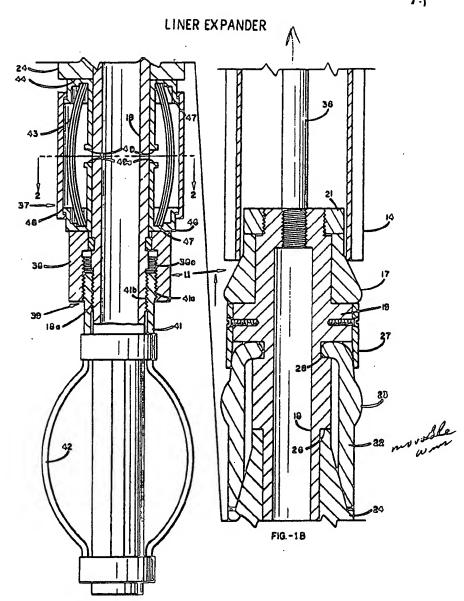
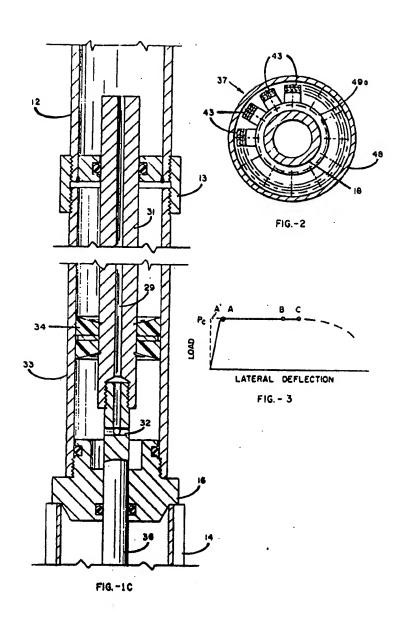


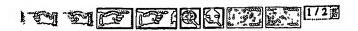
FIG.-1A



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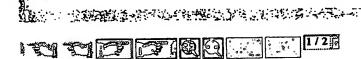
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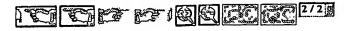
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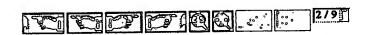
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is described with the process teaching there to provide a conoral force opting down which emprises a belt maker, at observed color
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to description and the executary and an executive see that follow-

Maria 14, 10 at 16, tend tender, and the o partial and these trou of a partial and the security to the process installed at

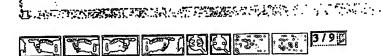




Haure 2 to a sportional view of the apparetes of Figure 1A taken at

Figure 3 is a typical plot or applied land versus infliction for the constant fuen oping device of the invention.

Inferring to the drawings, Pigure 14 in the bottom parties of a liner expending took for one is installing a autable lines in a coll, while Photo 10 illustrates the sicile excites of seal a beat and legan 20 source. क्षात क्षेत्र प्रमुक्त करनीक भी क्षेत्र क्ष्मा. क्षेत्र क्ष्मान क्ष्मा 11 10 क्ष्मिक्री क opened will taking in by emplied if end, typically, my to located then the 10 Formers through a well easing (not about) to a point in the contact at which it to sected to install a metallia liner. Betwee investing the tool into the all, a classic variably converted than the field the classical from the classical field of er other suitable suitable exterial, to placed as the test. The corrected liner is seemed in portion by emiser at its upon on with a cylindrical checkles combor 16 and, at the lower and by sentent with a first-otage expecting the 17 in the form of a tremental edrouber some school correspond to a firstotup expending his in the execut bernianther described. The expending his is finally abtached to a controlly located, elemental epiterrical ballow shaft lo thich force a parties of the body of the tool. As down, the committee the 17 त्ती त्यां विकास हा कारिक का है। स्थायक प्रता व कार्यां का है वर्ग की विस्त वर्ग mate. A planetty of morals are to presently provided out and willy लाकट्री प्रान्धिक की स्थान के क्या है, तर सेवहरूट का की केस है का वह वह स्थानिक හෙත් ස්ථාර 18. බිස ක්ෂල් පුත්තෙ ය වස යන හි ඇත ක්ෂල කත් ක්ර مساور مساور المارية والمارية و lier ico a marterially oriential deps. The are ceres at the partially المعرضا في الشيارة والمستبد معامل من من من المستبد المعامل المناسبة المامية ال مهمالين بستيم كا مادهما به والدسين ما فله مليان موسية من منسين منها क्यून्योग. क्रिन क्यांका वर्ष क्षेत्र क्रिक्त क्षेत्र क्रिक्त क्रिक्त क्रिक्त क्षेत्र mars to out to the one and one the econolly. Mentopouly, the अ अवस्थित कर्माच्या वर्ष क्षेत्र क्ष्मक वर्ष व्या क्ष्म क्षमक वर्ष व्यापक वर्ष व्यापक वर्ष व्यापक वर्ष व्यापक वर्ष two exting northern, topically cotogonal in atmo. The conjunity of the can minors to centralled by the product of the makes the folial mass operating





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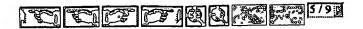
will it emitable studies to provided on the staff. As making it was in a construity direction area for fall invertily topond the about. The empending area 22 are half to place on the shaft by calles of east exceller groups all provided on the shaft.

The expending tent, experience the first-stage die can the sectionoracy die to drawn through the linear to expend to the piece in the section. Do first-oracy die provides a great deformation of the linear on that it is expended extraordly explicit the wall of the section. She consent-oracy die than passes through the litter and particles the fixed expendica to constat the linear sections of the litter and to croside note over exploses have bed little and the wall of the enough and effect a fixed-light smal.

In exerction, the limit estima took to exercise at the exercise, so described above, and a glass though someted with a restaura material may be wropped areas and consequently lates to their the liters. But also cold to lowers into the mil का कि limited of order to the to sole & liquid, each a stl, to the permit order prosecre does the soll taking ord floor threat. the perceptor 29 provided in political red 31, through parts 52 and into cylinthe 35 constoled to the upper and of the absorbler 16. Upon the application of the princes to the syllator, the pieter is covered to pedicion and it would would in original 33. As mans, red 36 minors palished red 34 and about II was acted to marked as numbershop amposited ato 17. Them the places of como como timo de mante II to coming do 17, cui to comistory the III are these character tops the constraint time in the first exthe convenience to the little, so that the superior little may content the tender will of the coates in which it to being teachilds. Resistant to the شيط الا نشيب ويدرو محمد من من ها ها حمدت ويتأسوه من جماع المداد to क्योंकरने ६० क्येंक सेक क्यूक्तीकर सक्केट स्तुतांकर सेठ स्यूक्तीकर क्या 82 तस्के व entrationly accretic form. On form award extent the uni mixture being oranizationly amount, the force translated through the one minor to the المد سا له الله معدد والمنامع بالمنامع بالمنامع منا المنامع منا المنامع منا المنامع ال فقع والمراجع المراجعة المراجعة

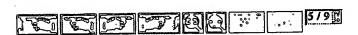


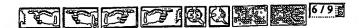
DENEMBER OF THE PROPERTY OF TH



large between the tool and the liber and the premiure emerical epithes the moing are maintained at presentantiated eats levels. The company fortion opting makes accurate that the contact produces between the liber founds partial at of the come 20 to great march to provide the bestern defermation of the adding, while provening deman to the coaling or to the tool.

The special force operat space of to alterate material as the shafe मि वर्त हिंदी हिंदित के अधिकार के व्यक्तियां के व्यक्तियां हिंदित के व्यक्तियां हिंदित हैं mine to ferring a parties of a differential array along the basicalta थ्य क्षेत्रीक्ष क कृतिन् क्यांच्य जिल्ला क्यांच्या क्षेत्र क्ष्या क्षेत्र क्ष्या क्ष्य जो स्मानिक क्षात न्यांच्या कि हा क्ष्म क्ष्मिक वर न्यांच्य कर न्यांच्य क्ष्मिक الكان الله المحمد والمحمد المحمد المح क्योंक हो क्रकार्यन वास सम्बन्ध होत ता होत व स्थ वासक व्य का स्थापित, responsible to the state through on the analt and the shoulder. En the क्षांच वर स्थापनीय क्या क्यांक, क्यांने वर अकृत्यक, क्यांनीओ अकृत्यक, वर देवन स्थापनीय, to withstand wary high lands and differ in patch so that complying \$6 to cover property on the obust 18 then the obust is revolved relative to thirdle bl. क्ष्म त्यान हो के कल्लास्य क के क्षेत्र के कि क्ष्मिक के का स्मार के क्ष्मिक के कि langitudically, but it is not free to rotate on to sharts. Munity artected to the land of the therein to a stilletter conter, and to be surroug the, a bytrouliably estuated friction per, or other such device for frictionally चल्लाला. त्वंदी क्षेत्र अंदार्थन क्यों वर्ष क्ष्य क्ष्यांका के तकत्व क्ष्य क्ष्यांकी व्यवस्था المصافية على المستمار المراسية المراسية المراسية على المستمالة المراسية الم مستنين الشينية الله الله الله من من من الله من سا تحسان سا ت بادع در اسل مر محسان الله به والرشاع ومات س ट्या वर ट्यापि प्रेके, वर्षक क्ष्म व्यक्ति क्ष्मक व्यक्ति क्ष्मक क ट्याप. के ब्राय . mans, decision constitue of the court relative to the thirds arms الما والمعالمة ما المعالمة ما المعالمة TOTALLY CO CONTROL OF TO THE PARTIES. FOR ORIGINA, CO CALIFORNIAN, differential cores was ento to read files and essential trainferent excess <u>්ග ස 8 හින්දී දෙනසේසක්වූ 1.7-4ක් සෑස්ස් ශ්යාහා ස් කිත ස් කිතේ</u> thereto/look oper through a scholar opposition 8.5-desire





Consecut form option obscar 17 comprises which obscars \$3, at contact commit contact of or phrolity of elegated column dispose and at the life. Typer bearing plate where \$6 is no contact with the dispose and of the column and to elicible positioned on share if to become to the column and to positioned an share if to become the force of the spring large tribuilty options the bother and of the column and to contact the bother and of the column and to contact the matter plate where the local state of the column and to contact the contact of revolving distinguished more almost \$9. Greenes \$7 are provided to made of the bearing plates, to firm an experience of a lover even, into which the contact of the column are increased. These presence are to account to compare the column and the column are almost in decreased. A cover the my increase of the column of the column and it foodered. A cover the my increased to amiliar flowers matter from the spring makes to protect the contact.

A some for Meditor the Coffeeding of the column to required. lither the color election to a booled sentrice, application of . monthly companies bent through while occurs total failure or replace of the column. Therefore, a poir of stope by me the are provided for this person. is there, the chaps are rigidly composed to the branks plates, cell, to offers experience that the second profession on the cash to ملاته المرافطاتيال المعادي. كم تعاد دا الم دادي شر يعاد المعادل به تعار المراه والمعروب والمراجع والمراجع المراجع المراجع والمراجع والمراع والمراجع والمراجع والمراجع والمراجع والمراع والمراع والمراجع و to promited from moting tem to least abundar की semanted to the abundant bil. क्रिक्टर, सेन दानबोग्र क्रिक्टर धन तथे to बब्दे as to little क्षेत्र स्ट्राहरियोग्री احتصام فصوص ما مطاحها ودع وعل بع وسنت عملو وواهما كا ال المومة ಹೊಸವರು ಪೆ ಬಿಂ ಯದಾ ಎಟವಾ b). ರಿಗಣ ವಿರಂದದಿನ ದಾಹ ಕೆಸ ಪ್ರಾರಂಧಕ್ಕೆ ತ್ತಿನ ಕೆಲ್ಲಾಂ ಕು ಜಾ ದಾರ್ವ ಎಟ್ಟಾನ್ ಎಟ್ಟ್ ಎಟ್ಟಾನ್ ಎಟ್ಟ್ ಎಟ್ಟಾನ್ ಎಟ್ಟಾನ್ ಎಟ್ಟಾನ್ ಎಟ್ಟಾನ್ ಎಟ್ಟಾನ್ ಎಟ್ಟಾನ್ ಎಟ್ಟ್ ಎಟ್ಟಾನ್ ಎಟ್ಟ್ मोक्ट क्ल्यांस्ट का १५५ क्लांक क्रवा क्रवान क्ष क्रवाहत, वा प्रेस क्लांक पेरी provided क्रांक catable escapeance and a collect to the proper to link leadingle ದ್ರ್ಯ htora ಅಗಿಂಡಣ ದ ಯಾ.

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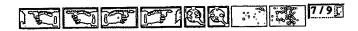




fitted classify together as there, or way to spared around the race, with some rotory wand between these to extend the destined opening. The resident of column explayed will depute their column characteristics and the embertain of construction. For comple, the standormes ratio of the column by to this videly, and the column criss as to ream!, flat, final or heaped. The professed conference to a thin, closer column with recorded auto, from to move within لك يعمد مخصد له لك متحمده ما لك دماسة وهد. كالمتاملة للله ما ك ಯೇಹನೆದ ಎದೆ ಎತಿಯಾ-ಯಾಹನದ statalogo ptools, ಇದಾಗಿದು ಅಂಕ್ರಮ ಶಿಕಾ ಎಟಿದ್ರಾ, ನಿಯ or personal posters, southern the site stated allow the other station mining providing considering meaning properties. Topically, the left-गांक्यो कोट्य कर को क्रिय म्हर्क्यक्रिया वस्त्य-क्रिक्स, स्त्रीक क्रियं क्रियं prestor than the inichross, and arranged so that the vices race of the universe to mend to the director of the chaft. Then, with martialized properties laming, the column borble, and lead about the aris having the least semper of leastin, o.g., outrought may from the about 18.

For comple, a group of column 5.164-tach thick by 0.838-inch wife ty 10.626-inches long, with the code respond, were fabricated from A.1.8.I 4350 oten), (presented and denies of 775%. But column was found to regard a in critical representation leading of MO pends in order to bealth the column. . After tending, the column was found to have a way that spring characteristhe, to there is Marco I, throats Po to the existing beautiful from the point C represents the local collection of which the chross in the outroop fileson ولا فله لتأليب وموسدا الله يقولا بمارة ولا لله المارة عند المارة الله وليه of this corter economicatoric corps to described by mores thisto. Assembly, this curve is shourthal by MIII due to friction in the system. Poless & end I recovered topical serving licito, which, of course, my to vertal asserting to the application for today the spring to deviced. For comple, there a large mine of floring option on me miliateric, a world also the this th to your paint my to mail, with order a meet motor of flowers, the vertiling where to the total to the time the common that of the extent of contra-Men. In the observational teats, the lateral teather to licited to

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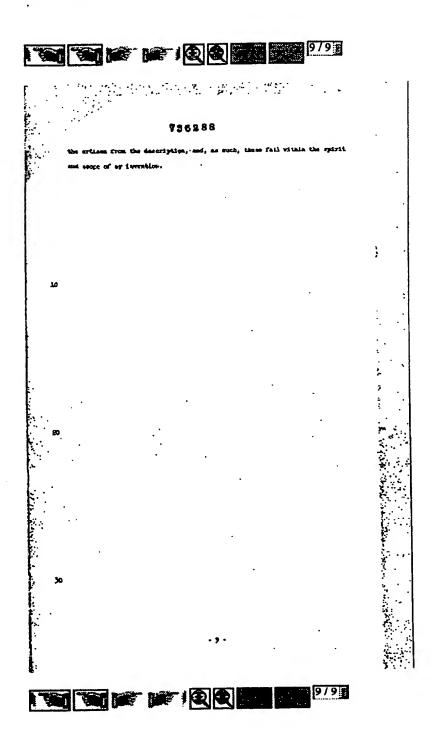
epprenamenty can bush, at which the longitudinal deflortion was experimitely 0.005 inches. From mrs defloction to the comman deflortion, the \$50-pound lacking was fruit to be coherentially constant.

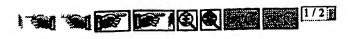
in contact that a spring device was built, as deem, caplotting 80 called, each interior a surface builting land of 1550 parts. Each interior called the form of 1500 parts, and interior between 0 and about 1.50 tacked by appropriately pool-builting the other. Each called the syring element builting the syring element builting the called the syring element builting of called the syring element of 0.60 tacked of called the calle

trocurse, in tentending a curing observe on above 14 in extending to obtain the growth possible value of implessions influenties for specifical values of located conficulties and critical tenting local, while unintending the atmospherical local in the columns at a case lovel. The preferred columns, therefore, tro locatedly on shown in Pigerro 18 and 2, with unitarity of the columns.

D in spirition of the above experient test for which a line is call moder, in mix-spirit is leaved take the well as motivated above, with the area 22 to the restorted parties. One its test is at the indirect leaves, the call their is evoluted. The friction makes to expect with the wall at the extent of process thinks is in a resolution. Whe covered to expect the indirect of the indirect leaves in the call to a produce that within the cover of the indirect leaves in the call the transfer of the call of the indirect leaves in the call the call indirect leaves in the call the call indirect leaves in the call in the call the call indirect leaves in the call in the call in the call the call in the c

en forcer (months of a present with the personal test to the person of amplification. It all to personal test water militarians to the best personal to the personal test to be the personal test to be the personal to the personal test to be the personal test to the personal test to be the perso





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